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OCONUS DEFOLIATION TEST PROGRAM

Semiannual Report No. 2

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SYNOPSIS

This is a second semiannual report on a test program to evaluate effectiveness of aerial spray applications of chemical defoliants in vegetation representative of Southeast Asia. The test program was initiated April 1964 on two test sites on the Pranburi Military Reservation, about 125 miles southwest of Bangkok, Thailand.

The interim defoliants, "purple", "pink" and "orange" were applied at 3 to 5 deposit rates and volumes during the dry season, December-March. Other defoliants, desiccants and herbicides were applied at 1 or 2 rates during the late rainy season (September-November) and in the dry season (March).

Evaluations of vegetation response to chemical treatments were made periodically by four methods: (1) changes in vertical visibility by a photographic technique, (2) changes in horizontal visibility by a target-obscuration technique, (3) overall vegetation and species response expressed as defoliation percent in reference to an initial vegetation inventory, (4) changes visible in vertical aerial photographs of test plots.

Treatments evaluated for a period of 4 to 6 months showed the following results:

(1) "Purple" and "pink" gave defoliation superior to that of other chemicals tested.

(2) "Purple" gave effective defoliation (greater than 65%) for a period of 2 to 5 months after treatment at rates of 1 or more gals/acre. "Pink" was effective for a similar period at rates of 1 or more gals/A.

(3) The desiccants, Diquat and cacodylic acid gave effective defoliation for a period of only 2 to 4 weeks after treatment.

(4) Dicamba amine and a mixture of Tordon and Diquat gave effective defoliation at 3 to 4 months but were in general less effective than "purple" or "pink".

A. INTRODUCTION

This report outlines progress of a testing program on chemical defoliants conducted in Thailand by the U. S. Army Biological Laboratories under ARPA order No. 423.

General objectives of the test program are: (1) to determine minimal rates and volumes of "purple", "pink" and "orange" applied at various seasons for effective defoliation and control of representative Southeast Asia vegetation, and (2) to evaluate the effectiveness of other selected defoliants, desiccants and herbicides applied singly or in combination mixtures on representative vegetation of Southeast Asia.

The test program is conducted in collaboration with the Military Research and Development Center of Thailand and its U. S. component, ARPA R&D Field Unit. (Thailand)

B. PREVIOUS WORK

The test program was initiated in April 1964 at two test sites located on the Pranburi Military Reservation near Pranburi, approximately 125 miles southwest of Bangkok, Thailand.

A twin-engine Beechcraft airplane equipped with a 180 gallon tank and 32 ft. boom has been used for applications of chemical solutions. Treatments are made on duplicate 10-acre plots at two test site locations. Applications have been restricted to early morning hours in which temperature inversion conditions allow effective deposition of spray.

Spray deposition patterns and rates for each treatment are obtained by supplemental calibration flights on a calibration grid made concurrently with test plot applications. Approximately 37 treatments with "purple", "pink" and selected defoliants and desiccants were made prior to the beginning of the present report period.

A coordinated program of treatment evaluation by visual observation, vertical photography, horizontal visibility determinations, and aerial photographs was conducted at regularly scheduled intervals.

C. TEST APPLICATIONS

Test applications were continued on a regular schedule in accordance with the sequences stated in the revised test program. Applications of selected defoliants and desiccants were made in October and November 1964 and in March 1965 as shown in the appended Tables 1 and 2. Chemicals tested included merphos, tributyl phosphate, amitrole, cacodylic acid, cacodylic salt, diquat, butyne diol, folex, endothal salt, endothal acid and Tordon in mixture with diquat and 2,4-D amine.

Tests to determine minimal effective dosages of "purple", "pink", and "orange" were made during the dry season in December 1964 and in January and early February 1965 as outlined in Table 2. Tests with "orange" were delayed due to transportation difficulties in shipment of chemicals.

A series of tests was initiated in January 1965 to evaluate the effectiveness of repeated applications of "purple" and other chemicals. Three areas designated as Special Treatment Areas A, B, and C were given initial applications of "purple" at 1.0 gal/A, 1:1 "purple"/diesel fuel at 2.0 gals/A and 1:1 "pink"/diesel fuel, respectively in late January and early February. Repeat applications will be made on duplicate 10-acre plots as indicated in the following schedule.

Schedule of Repeat Applications

Special Treatment Area A

Initial	100% Purple	1 gal/A
Repeat		
Plots 1 & 5 at 2 months	100% Purple	1 gal/A
Plots 2 & 6	none	
Plots 3 & 7 at 2 weeks	Cacodylic acid	1.5 lbs/A
Plots 4 & 8 at 4 months	100% Purple	1 gal/A

Special Treatment Area B

Initial	1:1 Purple/diesel	2 gal/A
Repeat		
Plots 1 & 5 at 2 months	100% Purple	1 gal/A
Plots 2 & 6	none	
Plots 3 & 7 at 2 weeks	Cacodylic acid	1.5 lbs/A
Plots 4 & 8 at 4 months	100% Purple	1 gal/A

Special Treatment Area C

Initial	1:1 Pink/diesel	1.0 gal/A
Repeat		
Plots 1 & 4 at 2 months	1:1 Pink/diesel	1 gal/A
Plots 2 & 5	none	
Plots 3 & 6 at 4 months	1:1 Pink/diesel	1 gal/A

An additional series of four duplicate 10-acre plots was treated initially with 1:1 "purple"/diesel fuel at 2 gals/A in February 1965. Duplicate subplots will be treated with the same chemical mixture at 1-, 2-, 3- and 4-month intervals to determine the desirable frequency of retreatment to minimize vegetation regrowth.

D. FLIGHT CALIBRATION TESTS

Prior to initiation of test applications in April 1964, flight calibration tests and modifications of boom configuration were made to secure relatively uniform spray deposition patterns for various chemical mixtures at 1.0, 2.0 and 3.0 gals/acre. Flight calibration tests were continued concurrently with all plot treatment applications to confirm actual deposition rates. Applications were made on a 100-ft swath at a height of approximately 30 ft above vegetation canopy.

Flight calibration tests consisted generally of 2 or 3 spray passes on the calibration grid. DuPont oil soluble red or Rhodamine blue dye was added to the chemical mixture to secure colorimetric data on spray deposit rates on 6 x 6 inch stainless steel plates spaced at 10 ft intervals. Calibration flights were made in-wind at wind velocities of less than 5 miles per hour. Wet-plate acetone wash and spectrophotometric technique were employed to establish spray deposition volumes expressed in gallons/acre.

Calibration tests of water soluble chemicals such as diquat and cacodylic acid showed that approximately 50% of delivered volumes was recovered on the grid sampling stations. During the course of tests with the group of selected defoliants and desiccants modifications of nozzle orifice size and nozzle configuration were made in attempt to secure higher recovery percentages of delivered volumes. The relatively higher evaporation rates of water solutions and consequent loss of small droplets are considered the principal factor contributing to the lower recovery rates in contrast to those of the more viscous "purple", "pink" or diesel fuel mixtures with the latter chemicals.

Meterological observations were made at the calibration grid on the Pranburi Military Reservation and at supplemental stations located in proximity to treated plots in the test sites.

Wind direction and velocity measurements at 30 ft height were made on a portable telescoping tower stationed at the calibration grid. Data on dry bulb temperature at 4 ft and 30 ft were secured to determine inversion conditions during the period of test plot and calibration flight applications. Hygrothermograph and precipitation records were maintained at the grid location.

E. TEST PLOT PREPARATION AND MAINTENANCE

A major portion of the access lanes to treatment plots and camera station trails within the treatment plots in the two test sites had been completed by September 1964. However it was found necessary to survey and relocate some camera station trails to [illegible] test evaluation techniques could be properly applied to treated areas.

Labor crews consisting of two supervisors and two groups of six laborers were employed in maintaining and clearing lanes and camera station trails, in the positioning of treatment plot flags prior to treatment application and general access road maintenance to the test sites.

F. VEGETATION INVENTORY

A preliminary vegetation inventory of treatment plots has been completed for all prospective treatments. The inventory has been made by a Thai forester and helper. Species compositions were determined within a central 500-foot long strip in each treatment plot adjacent to the six camera stations positioned at 100 ft intervals.

Individual trees and shrubs were tagged by code number along the 500 ft evaluation transect for later recognition and evaluation of species response to treatment. The numbers of tagged trees were tallied in the inventory which also include a location map of species in a circular plot around each of the six camera stations.

Specimen collections have been made of all woody species encountered on the test sites. Identifications have been furnished by Tem Smitinand, Forest Botanist of the Royal Forestry Department and other botanists of Kasetsart and Chulalongkorn Universities in Bangkok. Further verification and identification of plant specimens has been made at the Singapore Botanic Garden Herbarium and at Kew Gardens Herbarium, London, England. A total of 216 plant species has been recorded from the test site inventories of which 35 to 50 are frequently encountered in plot tallies.

Table 3 shows the vegetational composition on the two test sites based on the inventory data of treatment plots 1-60. The dominant tree layer consists of six principal species in each of the two sites. The dominants constitute approximately 10% of the total vegetation composition based on numbers of individual plants tallied in the inventory.

Important species in the intermediate tree layer include Cleistanthus heterophyllus and Streblus zeylanica on Test Site I with percentage, composition of 29.0 and 42.4 percent, respectively. These species are also predominant in the shrub layer of Test Site I altho not recorded in Table 3. Bambusa arundinacea (bamboo) and Streblus zeylanica each make up more than 10% of the composition in the intermediate tree layer of Test Site II. Shrubs are important in this site with Acacia comosa and Cleistanthus sp. comprising 14.5 and 12.6 percent, respectively, of total vegetation.

G. EVALUATION

Four methods of evaluation are used to measure the effectiveness of test evaluations. All evaluation techniques are applied on a prescribed regular schedule and are continued until negligible responses to treatment are measured.

1. VERTICAL PHOTOGRAPHY

Improvement in vertical visibility is measured photographically at 6 camera stations in each treatment plot. Exposures are chosen so that the sky is rendered dense black in the exposed negative while the forest cover is drastically underexposed, thus producing a silhouette of foliage and branch detail. Measurements of light transmittance through the negatives by means of a photoelectric densitometer with readings before and after treatment provide comparative data on vertical visibility changes based on original conditions.

Two technicians photograph 35 to 50 plots a week with duplicate exposures at each of the six camera stations per plot. As of March 1965 more than 20,000 photographs had been made for this evaluation technique on the 79 treatments completed. It is estimated that an additional 7500 photographs will be needed to complete this evaluation method.

Basic data from this photographic evaluation technique is now being compiled and analyzed.

2. HORIZONTAL VISIBILITY

This technique involves measurement of horizontal line-of-sight visibility on 8 azimuth lines radiating from one central point in each treatment plot. The target consists of 3 white discs (each with 25 dots) spaced at 0.5, 1.2 and 1.9 meters above ground on a vertically-positioned pole. The number of dots visible on each disc has been recorded at distances of 5, 10, 15, 20, 25 and 30 meters from the central point along each of the 8 radiating lines. Observations are taken by means of tripod-mounted binoculars which can be sighted along the selected azimuths. Data may be converted to the average number of target points visible per azimuth or to percentage visibility change based on original or control plot readings.

Table 4 presents data on horizontal visibility changes due to selected treatments. Applications of "purple" and "pink" cause a maximum increase in horizontal visibility at intervals of 2 to 4 months following treatment application. Much earlier responses are shown by active desiccants such as cacodylic acid and Diquat; maximum change in horizontal visibility may occur at 2 to 4 weeks following treatment. All treatments observed for periods of 6 to 9 months have exhibited a decline in

horizontal visibility caused by vegetation regrowth following the initial defoliation response.

The more effective treatments may show an increase in horizontal visibility in excess of 100% based on the average number of target points visible per line.

Modifications of the horizontal visibility technique have been made following statistical tests of method error. Under the modified system marked target locations are used for all subsequent observations at distances of 10, 15 and 20 meters from the central point. In the old system the confidence interval of the difference between two successive readings on the same plot at the .95 probability level was 25.5% of the total target dot count. Using the new system of marked locations the confidence interval for successive readings is 10.4% indicating a reduced inherent error or variability. The statistical study indicated that the 5-meter interval readings were of no value because targets were 100% visible at this distance. Data from 25 and 30 meters were not reliable. 100% variability was encountered between successive readings at these distances as very few target dots were visible. For these reasons subsequent data will be taken only at 10, 15 and 20 meter intervals.

3. VEGETATION EVALUATION

Vegetation response to treatment has been recorded at weekly and monthly intervals by observations in the area between camera sites 1 and 6. Data consist of appraisals of defoliation of the dominant, intermediate and shrub layers as well as overall vegetation and individual species responses expressed as % defoliation.

Species observations are made on individual marked trees identified at the time of vegetation inventory (prior to treatment).

Table 5 summarized data from treatments showing effective defoliation (overall ratings of 65% defoliation or greater). The periods in which effective defoliation occurred and the maximum ratings are shown for treatments which have undergone 6 months or more evaluation. Dry-season applications of "purple" and "pink" did not receive a full series of evaluations and the data presented show only the period of observation.

In general applications of "purple" and "pink" are effective for a period of 2 to 5 months following treatment. The desiccants, cacodylic acid and Diquat, are most effective at 2 to 4 weeks after treatment.

Maximum defoliation values of 80 percent or more were obtained with applications of 10 lbs (1 gal/A) or more per acre of "purple" and slightly smaller amounts of "pink". Diquat gave comparable ratings at 5 lbs/acre which would involve considerably higher chemical costs than "purple" or "pink".

In general observations of vegetation response made at the camera stations in each treatment plot have furnished information on the reliability of the horizontal visibility and vertical photographic data. Observations of swath coverage have indicated whether or not data collected at specific camera stations are valid expressions of treatment.

4. AERIAL PHOTOGRAPHY

Aerial photographs have been taken on 35 mm Kodachrome of selected test plots and the test sites at weekly or biweekly intervals from October 1964 through February 1965. Photographs are taken at an oblique angle from an elevation of 1000 ft.

Examination of serial photographs taken within 2 to 4 weeks following application permits an evaluation of swath coverage and the rate of progress and effectiveness of individual treatments.

A KD10A Maurer Aerial Camera has been borrowed from the Bureau of Naval Weapons for additional aerial plot photography using 70 mm Ektachrome and Infrared color film. Two photo flights were made in March using this equipment.

H. GENERAL RESULTS OF TEST APPLICATIONS

1. RATE TEST OF "PURPLE" AND "PINK"

Evaluations over a 6-month observation period are given in Table 6 for treatments with "purple" and "pink" applied in August and September 1964. The heavy rate of "purple" (2.5-to 3.5 gal/A) gave effective defoliation (65% or more) from 2 to 6 months after treatment. At 1.1 gals/A, "purple" gave effective defoliation only at the 3rd month after treatment. Later less than 1 gal/A gave less than 65% defoliation.

"Pink" applied at 2.5 gals/A gave effective defoliation at from 2 to 6 months after treatment. "Pink" gave effective defoliation at rates of 0.9 gal/A and more for periods of 2 to 5 or 6 months.

2. SELECTED DEFOLIANTS AND DESICCANTS

Table 7 presents data on other selected chemicals. Dicamba amine and Tordon gave herbicidal responses which resulted in effective defoliation for intervals of 4 to 6 months.

Cacodylic acid and Diquat produced desiccant effects which were maximum at intervals of 2 to 4 weeks following treatment. Five pounds per acre of Diquat were needed to produce defoliation equivalent to 1 gallon/A of "pink" or "purple".

Butyne diol, tributyl phosphate, merphos, endothal salt, and endothal acid were generally ineffective.

TABLE 1. SPRAY DEPOSIT RATES AND VOLUMES OF TEST APPLICATIONS WITH SELECTED DEFOLIANTS, DESICCANTS AND HERBICIDES, Sept 1964 - Mar 1965

TRMT. NO.	DATE	PLOT NO.	CHEMICAL MIXTURE		TOTAL DEPOSIT VOLUME (GAL/A)	DEPOSIT RATE ACTIVE INGREDIENT (LBS/A)
			CHEMICAL	SOLVENT		
38	25 Sept	J - 12N 11 - 24	Merphos	Diesel	2.9	22.0
40	5 Oct	2 - 32 J - 20S	Merphos	Diesel	3.7	28.0
39	2 Oct	J - 20N 2 - 40	Tributyl Phosphate	Diesel	3.0	24.0
41	15 Oct	J - 12S 2 - 24	Amitrole	Water	2.7	6.3
42	17 Oct	H - 12 4 - 36	Cacodylic Acid	Water	2.8	6.0
44	22 Oct	H - 28 4 - 20	Diquat	Water	3.0	2.8
43	19 Oct	H - 20 4 - 28	Diquat		2.5	5.0
46	6 Nov	5 - 28 H - 44	Butyne Diol	Water + X-155	3.1	11.0
47	13 Nov	5 - 36 H - 52	Folex	Water	3.4	13.0

TABLE 1. SPRAY DEPOSIT RATES AND VOLUMES OF TEST APPLICATIONS WITH SELECTED DEFOLIANTS, DESICCANTS AND HERBICIDES, Sept 1964 - Mar 1965 (Cont'd)

TRMT. NO.	DATE	PLOT NO.	CHEMICAL MIXTURE		TOTAL DEPOSIT VOLUME (GAL/A)	DEPOSIT RATE ACTIVE INGREDIENT (LBS/A)
			CHEMICAL	SOLVENT		
48	14 Nov 16 Nov	N - 4 R - 0	Endothal Salt	Water	3.4 2.2	5.3 3.4
49	19 Nov	N - 12 R - 8	Endothal Acid	DMF	2.8	5.5
50	27 Nov	N - 20 R - 16	Tordon + Diquat	Water	3.2	1.2 Tordon 2.5 Diquat
51	28 Nov	R - 24 M - 20	Tordon + 2,4-D Amine	Water	3.0	2.3 Tordon 5.3 2,4-D Amine
70	1 Mar	H - 16 3 - 56	Cacodylic Salt	Water	0.9	1.8
71	4 Mar	H - 24 4 - 40	Cacodylic Acid	Water	1.7	3.4
72	8 Mar	H - 32 4 - 24	Diquat	--	1.1	2.2
73	10 Mar	H - 40 3 - 16	Diquat	--	1.9	3.8

TABLE 1. SPRAY DEPOSIT RATES AND VOLUMES OF TEST APPLICATIONS WITH SELECTED DEFOLIANTS, DESICCANTS AND HERBICIDES, Sept 1964 - Mar 1965 (Cont'd)

TRMT. NO.	DATE	PLOT NO.	CHEMICAL MIXTURE		TOTAL DEPOSIT VOLUME (GAL/A)	DEPOSIT RATE ACTIVE INGREDIENT (LBS/A)
			CHEMICAL	SOLVENT		
74	18 Mar	H - 48	Amitrole	Water	--	6.0
		3 - 8	Diquat		1.0	2.0
75	22 Mar	R - 4	Tordon	--	1.5	3.0
		N - 4				
77	26 Mar	1 - 36	Dicamba Acid	1:3 Butanol-Water	2.0	12
		Q - 64				
78	24 Mar	1 - 8	Dicamba Acid	1:3 Butanol-Water	2.0	4
		Q - 72				
79	17 Mar	2 - 4	Endothal Acid	DMF	2.0	6
		Q - 80				

TABLE 2. SPRAY DEPOSIT RATES AND VOLUMES OF TEST APPLICATIONS WITH PURPLE, PINK AND ORANGE, Oct 1964 - Mar 1965 (Cont'd)

TRMT. NO.	DATE	PLOT NO.	CHEMICAL MIXTURE			TOTAL DEPOSIT VOLUME GALS/A	DEPOSIT	
			CHEMICAL	SOLVENT	RATIO CH/SO		TOTAL ESTER GALS/A	ACTIVE INGRED. LBS/A
59	1 Jan	G - 12 P - 40	Pink	Diesel	1:1	1.4	0.7	6.0
61	9 Feb	Q - 8 8 - 4	Orange	--	--	2.5	2.5	21.0
62	16 Feb 21 Feb	Q - 24 11 - 28	Orange	--	--	1.0 1.5	0.5 0.75	8.6 12.8
63	15 Feb	X - 20 Q - 16	Orange	Diesel	1:1	2.4	1.2	10.0
64	20 Feb	Q - 36 P - 56	Orange	Diesel	1:1	1.3	0.65	5.5
69	25 Feb	J - 165 1 - 28	Orange Ammon. Thiocyanate	Diesel	1:1	1.4	0.7	5.4

TABLE 3. VEGETATION COMPOSITION OF TEST SITES I AND II BASED ON NUMBERS OF INDIVIDUALS TALLIED IN TREATMENTS 1 THROUGH 60.

SPECIES	PERCENT COMPOSITION	
	TEST SITE I	TEST SITE II
DOMINANT LAYER		
Antheroporum pierrei	2.2	--
Dialium indum	--	0.6
Diospyros coaetana	0.8	1.9
Garuga Pinnata	--	1.0
Lagerstroemia floribundum	0.5	3.3
Manilkara hexandra	0.7	--
Millettia leucantha	1.4	--
Pentace burmanica	4.8	--
Pterospermum littorale	--	0.9
Terminalia pierrei	--	1.5
	10.4	9.2
INTERMEDIATE LAYER		
Atalantia monophylla	0.6	1.6
Bambusa arundinacea	--	10.7
Celtis collinsae	0.7	--
Cleistanthus heterophyllus	29.0	0.5
Combretum quadrangulare	--	1.7
Diospyros cauliflora	1.3	--
Euphorbia trigona	3.4	--
Grewia elatostemoides	--	1.3
Grewia tomentosa	--	2.4
Hydnocarpus ilicifolius	0.7	5.4
Memocylon ovatum	6.8	9.8
Olea maritima	--	2.7
Phyllanthus sp.	--	2.5
Sindora maritima	--	0.5
Streblus zeylanica	42.4	10.2
Vitex quinata	--	3.0
	84.9	52.3

TABLE 3. VEGETATION COMPOSITION OF TEST SITES I AND II BASED ON NUMBERS OF INDIVIDUALS TALLIED IN TREATMENTS 1 THROUGH 60. (Cont'd)

SPECIES	PERCENT COMPOSITION	
	TEST SITE I	TEST SITE II
SHRUB LAYER		
Acacia comosa	--	14.5
Capparis tenera	--	0.5
Capparis thorelii	--	0.9
Cleistanthus sp.	--	12.6
Combretum procursum	--	1.4
Drypetes sp.	--	1.4
Hymenopyramis brachiata	--	2.4
Sphenodesma pentandra	--	1.1
Ventilago calyculata	0.5	--
	0.5	35.8
Total	95.8	97.3

TABLE 4. EFFECTS OF SELECTED TREATMENTS ON HORIZONTAL VISIBILITY OVER A 6-MONTH OBSERVATION PERIOD

Trmt. No.	Rate #/A	Chemical	Date of max. increase in hor. vis.	Percentage increase at max.[1/]
26	9.5	"Purple"	2 months	37-70
30	20-30	"Purple"	3 months	35-36
29	4.9	"Pink"	2-3 months	25-32
27	8.0	"Pink"	2-6 months	67-136
34	9.0	"Pink"	4 months	135
31	20.0	"Pink"	2-4 months	82-123
42	6.0	Cacodylic acid	3-4 weeks	30-180
44	2.8	Diquat	2-3 weeks	42-75
43	5.0	Diquat	2-3 weeks	84-186
50	1.2 + 2.5	Tordon + Diquat	3 months	56
51	2.3 + 5.3	Tordon + 2,4-D	2-3 months	144-208

1/ Percentage based on the increase in number of target points per azimuth observed at maximum visibility compared to the original number visible prior to treatment.

TABLE 5. PERIOD OF EFFECTIVE DEFOLIATION (65% or greater) RESULTING FROM TREATMENTS WITH "PURPLE", "PINK" AND SELECTED DEFOLIANTS AND DESICCANTS.

Chemical	Rate (#/A)	Trmt. No.	Period of effective defoliation	Max. % defol.	Date of max. defol.
Dry season application					
"Purple"	25.8	9	3* - 6 mos.	90	3 mos.
"	20.6	2	4* - 6 mos.	85	4-5 mos.
"	15.4	7	3* - 5 mos.	85	3-4 mos.
"	10.3	1	4* - 5 mos.	80	4 mos.
"Pink"	13.8	4	3* - 5 mos.	85	3-4 mos.
"	8.6	8	3* - 4 mos.	85	3 mos.
"	7.7	5	4* - 5 mos.	75	4 mos.
"	7.2	6	4* - 5 mos.	80	4 mos.
Rainy season application					
"Purple"	20-30	30	2 - 5 mos.	70	2-4 mos.
"	9.5	26	3 mos.	70	3 mos.
"Pink"	20.0	31	1 - 5 mos.	75	2-3 mos.
"	9.0	34	2 - 5 mos.	85	4 mos.
"	8.0	27	2 - 5 mos.	65	2 mos.
Dicamba amine	15.0	22	4 mos.	65-70	4 mos.
Cacodylic acid	6.0	42	2 - 4 wks.	65	4 wks.
Diquat	5.0	43	2 - 4 wks.	85	4 wks.
"	2.8	44	2 - 3 wks.	70	2 wks.
Tordon-Diquat	1.2-2.5	50	3 wks.-3 mos.	70	3 wks.

* Date of initial evaluation.

TABLE 6. DEFOLIATION RATINGS OF TESTS WITH "PURPLE" AND "PINK" APPLIED IN AUGUST & SEPTEMBER 1964.

Chemical	Rate (Gals/A)	Trmt. No.	% Defoliation					
			1 mo.	2 mos.	3 mos.	4 mos.	5mos.	6 mos.
Purple 100%	2.5-3.5	30	30-50	50-70	50-70	55-70	45-60	55-65
Purple 100%	0.8	32	15-20	30	20-60	25-50	35-45	50-60
1:1 Purple/oil	1.1	26	25-35	30-35	45-70	35-50	30-45	15-25
1:1 Purple/oil	0.8	28	25	30	35-45	35-40	25-45	30-45
Pink 100%	2.5	31	40-60	45-75	55-75	55-70	45-70	60-70
Pink 100%	1.0	34	20-25	35-65	20-70	45-85	65	45-50
1:1 Pink/oil	0.9	27	30	50-65	40-60	45-65	55-60	55-65
1:1 Pink/oil	0.6	29	15-20	20	20-40	20-30	20-45	15-30

TABLE 7. DEFOLIATION RATINGS OF TESTS WITH SELECTED DEFOLIANTS & DESICCANTS, JUNE-NOVEMBER 1964.

Chemical	Rate (Lbs/A)	Trmt. No.	Date	% Defoliation						
				2 wks.	1 mo.	2 mos.	3 mos.	4 mos.	5 mos.	6 mos.
Dicamba amine	15.0	22	Jul	25-40	20-50	40-45	40-55	55-70	50-55	40-50
" "	7.0	23	Jul	15-20	30-50	40	35-40	30-50	45-50	25-70
" "	6.8	45	Oct	10	10-50	10-40	-40	45		
Cacodylic acid	7.0	13	Jun			30-50	30-40	10-15	--	
" "	5.0	14	Jun			25-30	10-15	-10	--	
" "	6.0	42	Oct	50-60	65	40-50	20-40	20-30		
Diquat	5.0	43	Oct	60-65	45-85	35-40	20-30	25-30		
"	2.8	44	Oct	50-70	40-45	30-40	20-30	25-35		
Butyne diol	11.0	46	Nov	25	20-30	10-15	10	--		
Tributyl phosphate	6.0	17	Jul	--	10-25	10	--	--		
"	24.0	39	Oct	10-15	10	10	--			
Merphos	12.0	24	Jul	10	0-10	--				
"	6.0	25	Aug	10	10	--				
"	28.0	40	Oct	10-15	10	10	--			
"	22.0	38	Sept	10-15	10	10	--			
Endothal salt	5.0	20	Jul	10-15	10	--				
"	3.5	21	Jul	10	10	--				
"	3.4-5.3	48	Nov	15-20	20-25	10-30	15-30			

TABLE 7. DEFOLIATION RATINGS OF TESTS WITH SELECTED DEFOLIANTS & DESICCANTS, JUNE-NOVEMBER 1964. (Cont'd)

Chemical	Rate (Lbs/A)	Trmt. No.	Date	% Defoliation						
				2 wks.	1 mo.	2 mos.	3 mos.	4 mos.	5 mos.	6 mos.
Endothal acid + DMF	3.5	49	Nov	15-20	15-30	10-15	20-25			
Tordon + Diquat	1.2+2.5	50	Nov	40-50	40-50	45-60	50-65			
Tordon + 2,4-D amine	2.3 + 5.3	51	Nov	10	10-55	40-55	55			

APPENDIX A

PERSONNEL

Personnel from the U. S. Army Biological Laboratories and their task duties on the project during the report period included:

1/Lt. Loyd M. Wax — 1 October - 12 December
Project leader, test application and evaluation

Pfc. Arnold Hungerford — 1 October - 22 December
Calibration, plot preparation evaluation

Sp-4 James S. Morrison — 28 October - 17 March
Vegetation Evaluation

Pfc. Wesley D. Pippen — 28 October - 31 March
Plot preparation vegetation evaluation

Sp-4 Robert L. McKnight — 28 October - 31 March
Test application, horizontal visibility evaluation

Dr. Robert A. Darrow — 3 November - 22 March
Project leader, vegetation inventory and evaluation

Sp-4 Richard A. Demyan — 22 November - 31 March
Chemical preparation and calibration

Sp-4 Paul T. Bertrand — 22 November - 31 March
Plot preparation, vegetation evaluation

1/Lt. Charles M. Bartlett — 29 January - 31 March
Test application, photographic evaluation

Pfc. Robert L. Decker — 5 February - 31 March
Calibration, vegetation evaluation

Dr. George B. Truchelut — 1 March - 31 March
Project leader, photographic evaluation

George A. Roth of Commercial Air Services, 11 March - 23 March, 1965
Honolulu, Hawaii, served as consultant
on modification of the spray distribution
system